

SANTIAGO 2013
**SYMPOSIUM ON
MICROGRIDS**

SEPTEMBER 11-12, 2013



Speaker: Vincenzo Antonucci

CNR-ITAE Microgrid Research

Institute for Advanced Energy Technologies "Nicola Giordano", Messina, Italy

Summary:



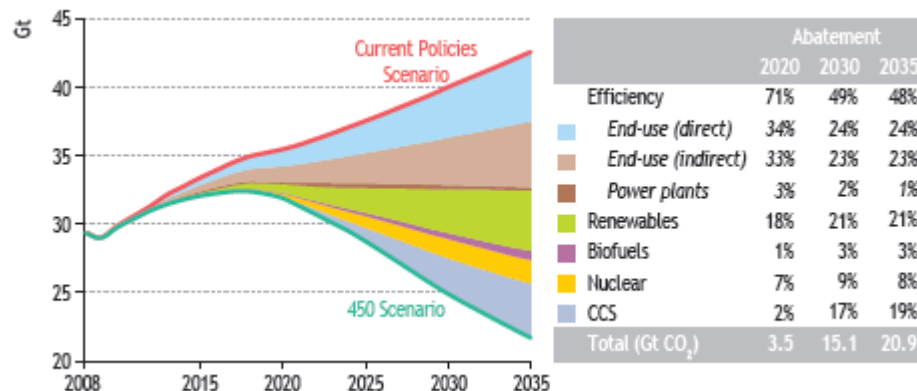
- ✓ **CNR-ITAE Involvement in European initiatives on Smart Grids and Smart Cities**
- ✓ **Italian Ministry on Economic Development – CNR Agreement:**
- ✓ **SMART HOME Project:**
- ✓ **I-NEXT Project (Smart Cities):**
- ✓ **OASIS ONE: Development of a containerized multi source energy station for remote zones**

CNR-ITAE Involvement in European initiatives on Smart Grids and Smart Cities

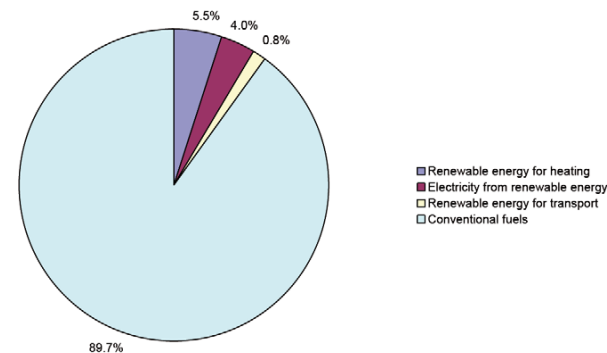
Achieving the Europe 2020 targets of the European Commission is forcing new challenges upon our society within the next years and calls for clear strategies in R&D in the field of energy. Because of the potential risks of worldwide climate change there is a strong need for urgent actions, arguably the most important being to reconceive the way we consume and produce the energy that we need.

According to the International Energy Agency (IEA) energy efficiency is one of the largest influencing factors for improving the critical situation our environment and society are facing

World energy-related CO₂ emission savings by policy measure in the 450 Scenario (World Energy Outlook, IEA, 2010)



EU-27 breakdown of gross final energy consumption in 2008 (Eurostat, Statistics in focus, Environment and Energy, 56/2010)



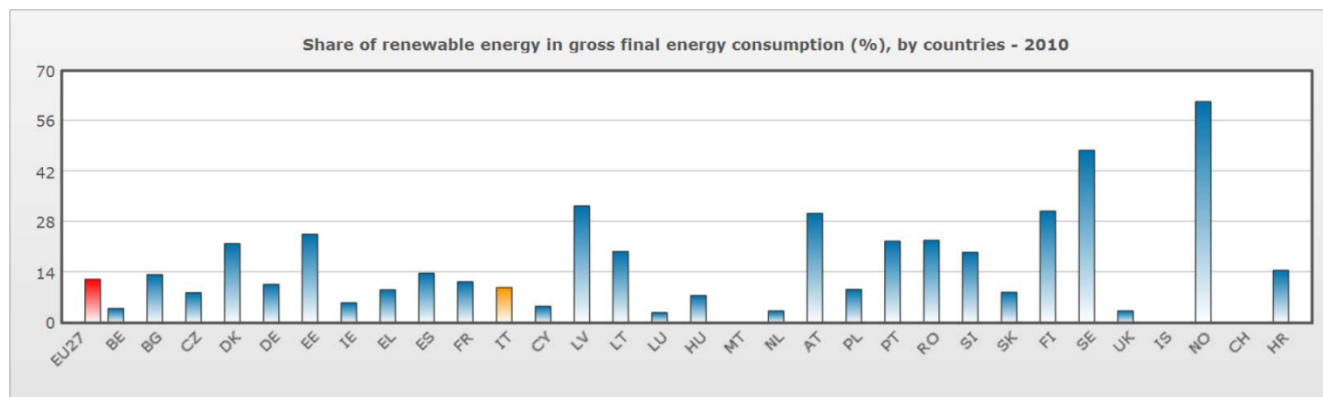
CNR-ITAE Involvement in European initiatives on Smart Grids and Smart Cities

Starting from Kyoto Protocol European Member States and European Commission are pushing the global energy policy towards the CO₂ trend reduction, the use of renewable energy sources and the increase of energy efficiency in buildings and in cities.



The "20-20-20" targets, set three key objectives for 2020:
A 20% reduction in EU greenhouse gas emissions from 1990 levels;
Raising the share of EU energy consumption produced from renewable resources to 20%;
A 20% improvement in the EU's energy efficiency.

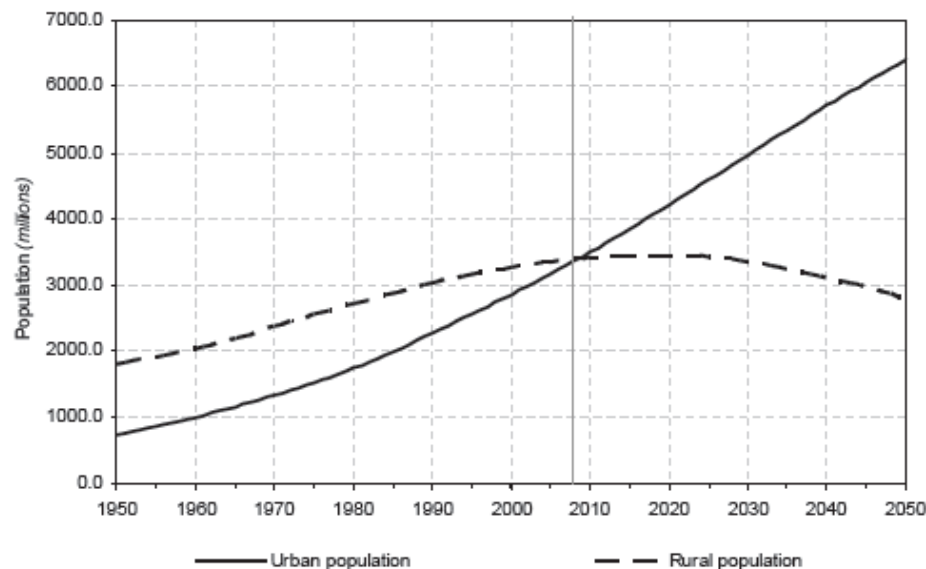
For **2050**, EU leaders have endorsed the objective of reducing Europe's greenhouse gas emissions by 80-95% compared to 1990 levels as part of efforts by developed countries as a group to reduce their emissions by a similar degree.



CNR-ITAE Involvement in European initiatives on Smart Grids and Smart Cities

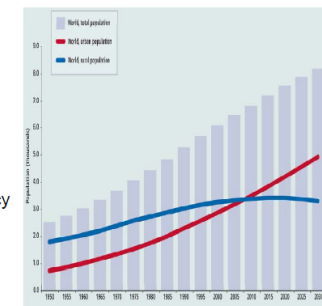
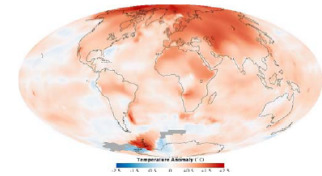
Why cities are so important?

Worldwide population trend for urban and rural areas (UN, World urbanization Prospects – The 2007 revision, 2007)



Background

- Climate change – CO2 reductions
- Dependency on fossil energy sources
- Strong coupling of CO2 emissions to GDP
- Increasing energy demand
 - Growth of population (7 bn in 2011, 10 bn in 2050)
 - Industrialisation
 - Increasing wealth + living standards
- Worldwide trend of urbanisation
 - EU: 2/3 of energy demand in/ around urban areas
- Challenge and chance
 - Urban areas display huge potential for energy efficiency
 - Cities as centers for innovation
 - Cities at forefront of policy, industry and research



www.eera-set.eu

Overview of city energy use and urbanization rate by regions and countries (World Energy Outlook, IEA, 2008)

Region	Share of city primary energy demand in regional total	Ratio of city per-capita primary energy demand to regional average	Urbanisation rate
United States	80%	0.99	81%
European Union	69%	0.94	73%
Australasia	78%	0.88	88%
China	75%	1.82	41%

CNR-ITAE Involvement on European initiatives on Smart Grids and Smart Cities

Which will be the role of micro grids in the future scenario?

Contest

Micro grids at building scale

Micro grids at district and neighborhood scale (CITY)

Grid security and security of supply

To distinguish between local and global perturbation

Frequency perturbation at electrical system level

DG Disconnection due to Interface Devices

Big amounts of power loosed in few seconds

Heavy Fault

Possible black-out

Frequency perturbation at local grid level (MV or LV)

DG Disconnection due to Interface Devices

The fault will be solved without DG

Voltage perturbation on MV feeder

DG on feeder determines a voltage increase

Passive grids vs active grids

Low power quality

High risk of fault

Energy Management

RES Aleatority

Micro grids can:

Encourage the Distribution Generation (DG)

Limit the dependency from hydrocarbons and centralized generation

Energy management at local level with the use of energy storage systems

Fault management at local level with the use of energy storage systems

CNR-ITAE Involvement in European initiatives on Smart Grids and Smart Cities

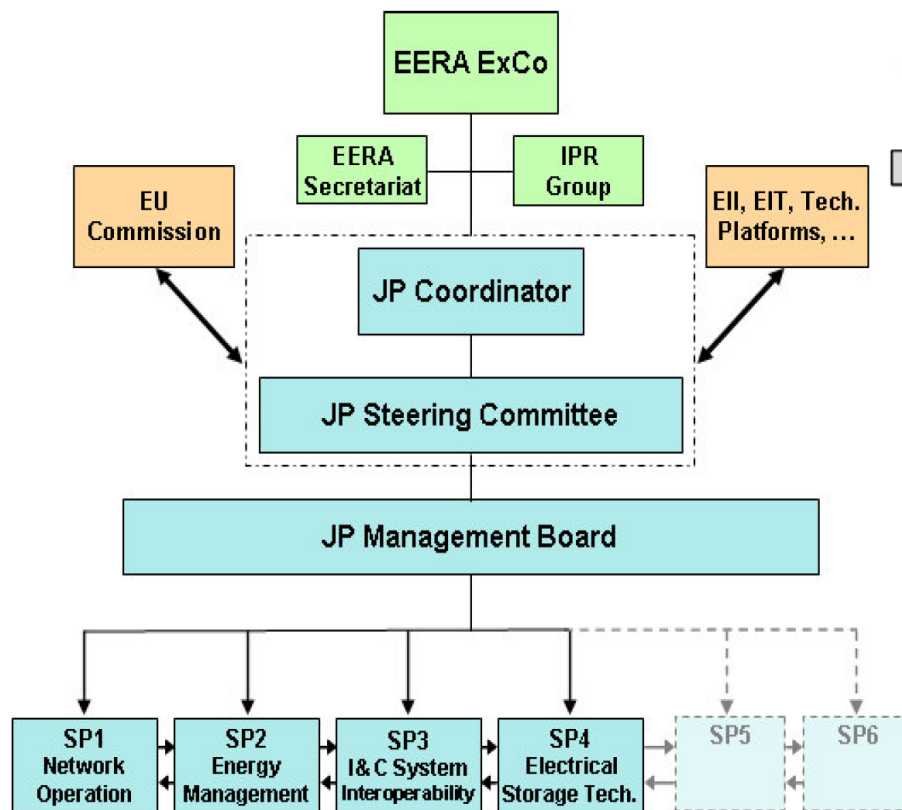
What is EERA?



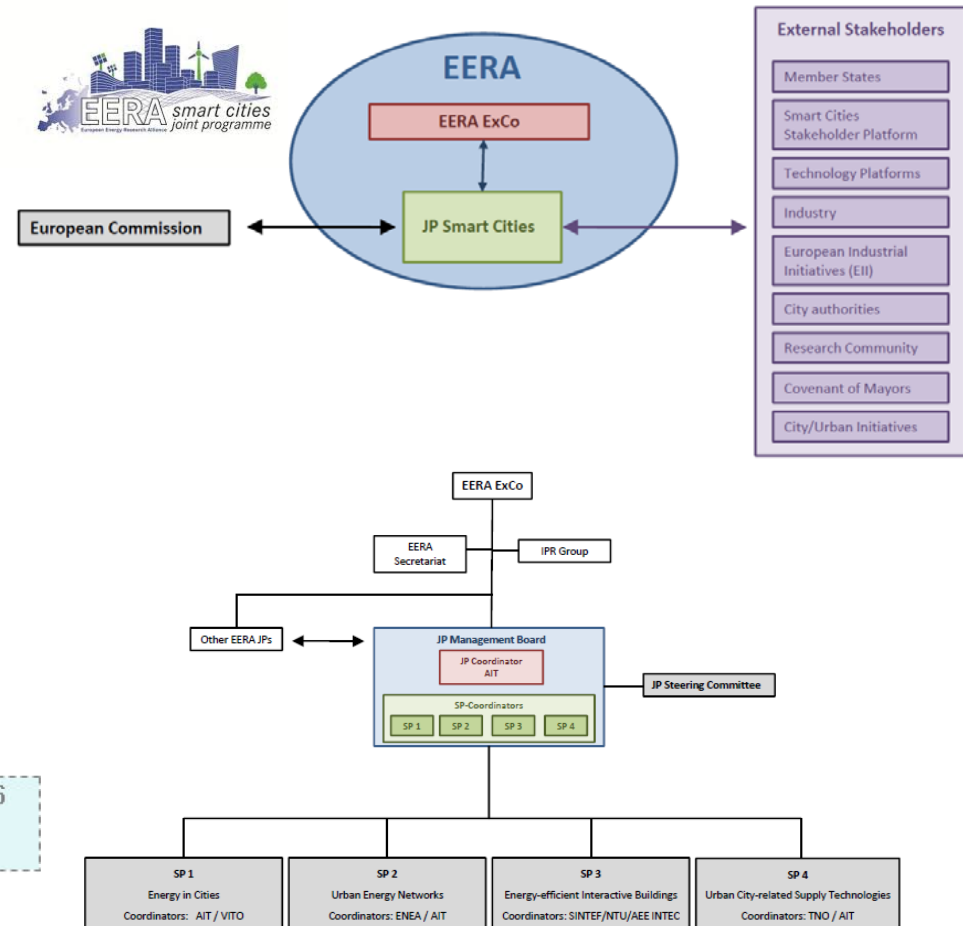
EERA is an alliance of leading organizations in the field of energy research. EERA aims to strengthen, expand and optimize EU energy research capabilities through the sharing of world-class national facilities in Europe and the joint realization of pan-European research programmes (EERA Joint Programmes). The primary focus of EERA is to accelerate the development of energy technologies to the point where they can be embedded in industry-driven research. In order to achieve this goal, EERA streamlines and coordinates national and European energy R&D programmes.

CNR-ITAE Involvement on European initiatives on Smart Grids and Smart Cities

Joint Programme on Smart Grids



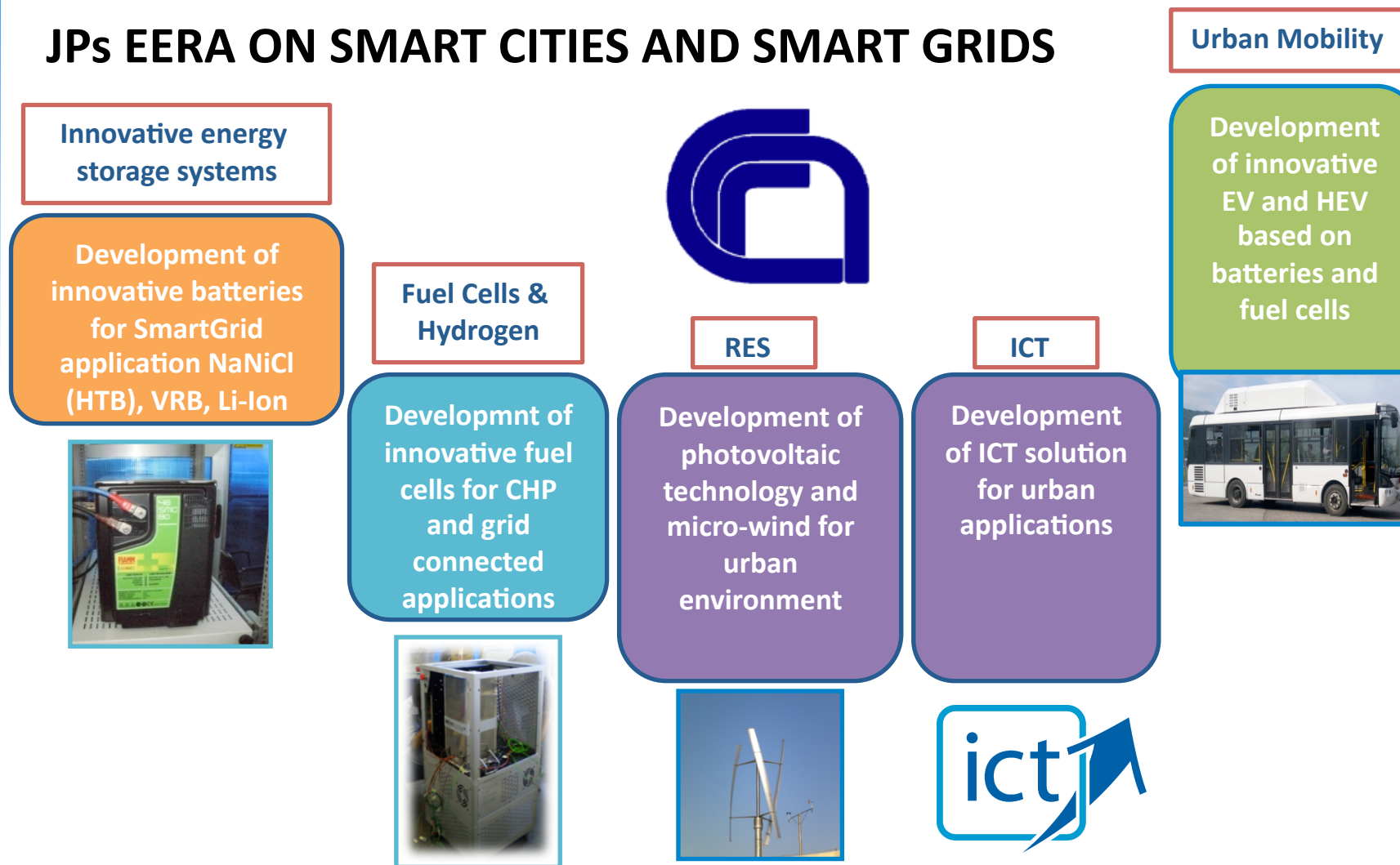
Joint Programme on Smart Cities





Joint Programme on Smart Cities

CNR PRINCIPAL FIELDS FOR CONTRIBUTIONS IN JPs EERA ON SMART CITIES AND SMART GRIDS



ITALIAN MINISTRY OF ECONOMIC DEVELOPMENT – CNR AGREEMENT



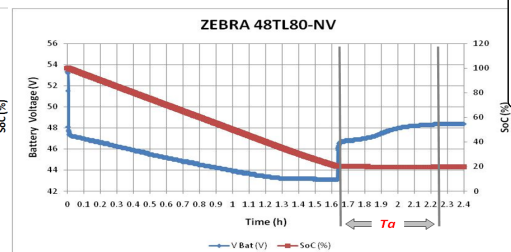
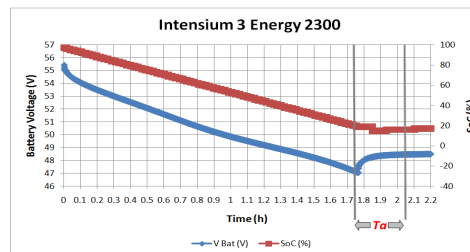
Electrochemical energy storage systems

Characterization and tests of batteries and energy storage systems



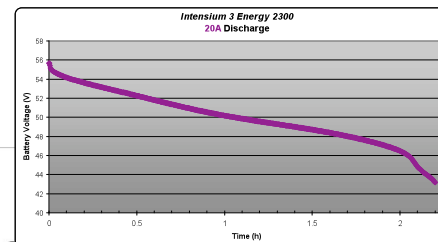
Comparison between NaNiCl and Li-Ion

- NaNiCl high temperature batteries
- Li-Ion batteries
- Vanadium Redox Flow Batteries

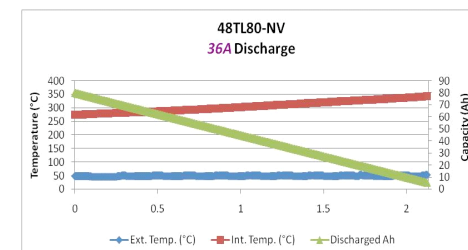
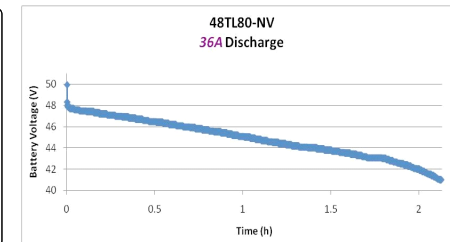


Relax time

Tecnology	Initial SoC (%)	Final SoC (%)	I discharge (A)	Ta
Li-Ion	100	20	20	30 min.
Zebra	100	20	20	35 min.



Intensium 3 Energy 2300
20A Discharge

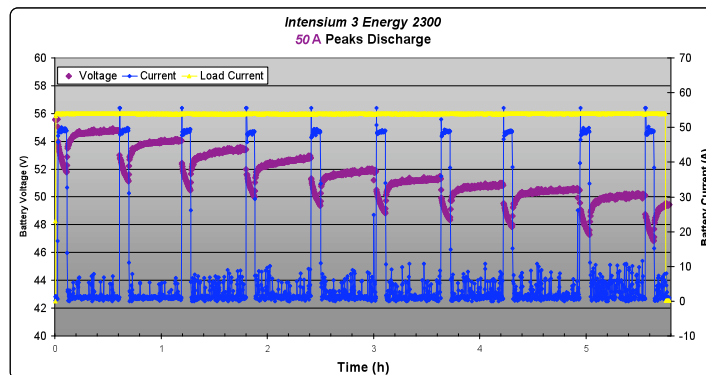
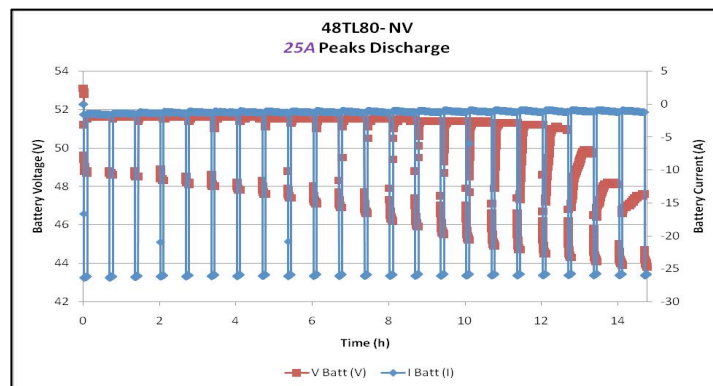


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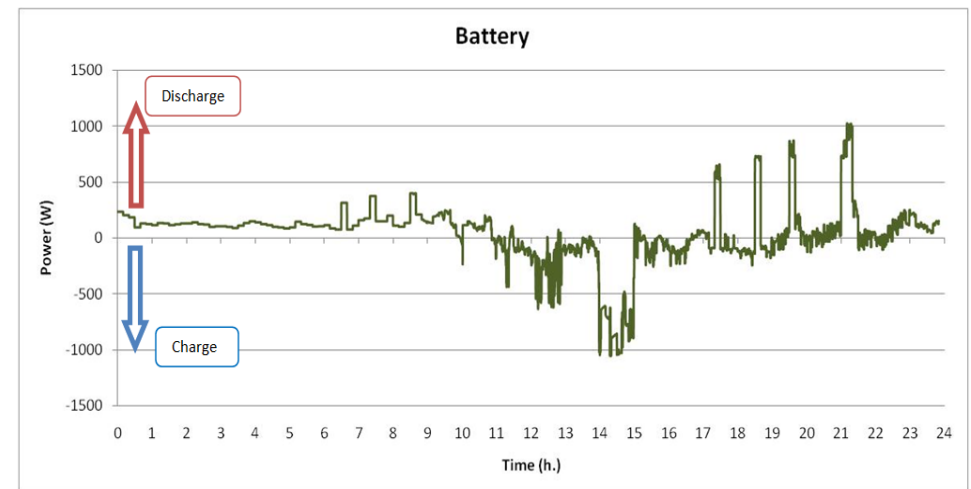
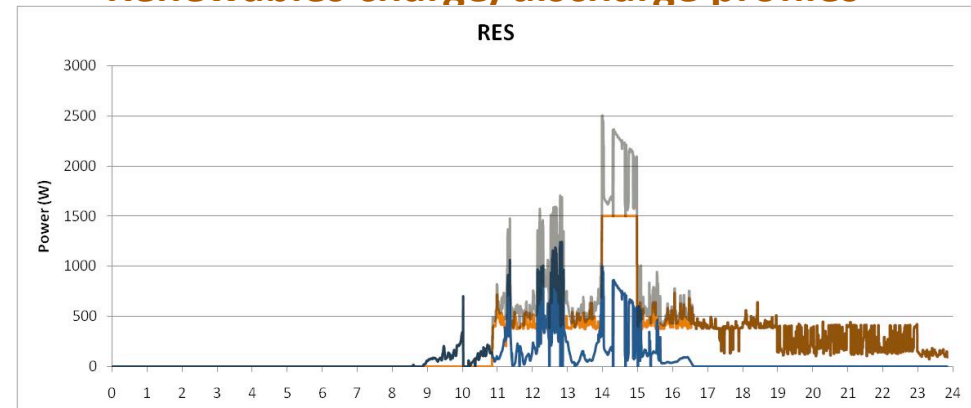


Protocols

Stress protocol varying peaks frequency and amplitude



Renewables charge/discharge profiles

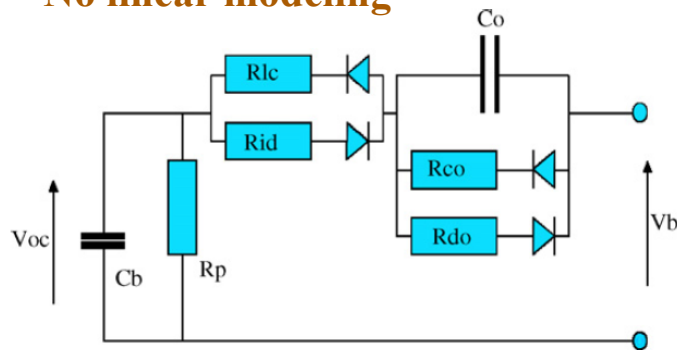


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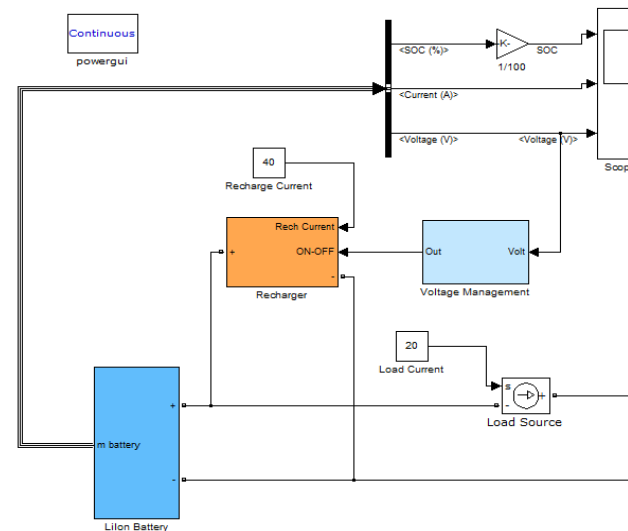


Modeling of energy storage systems and
simulation of the behavior in multi RES microgrid configuration

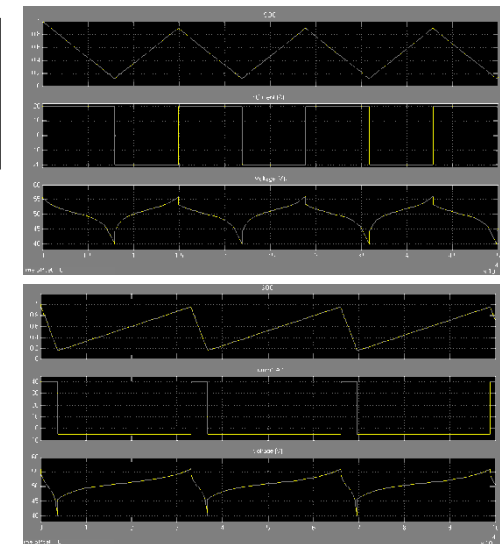
No linear modeling



Simulink modeling



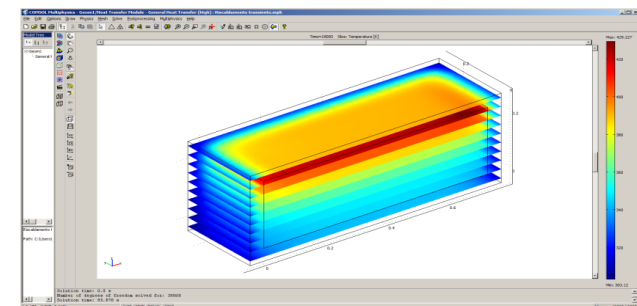
Simulation



Technologies modeled

- NaNiCl high temperature batteries
- Li-Ion batteries
- NiMH batteries

Thermal
Behavior
Simulation of a
NaNiCl Battery



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Modeling of energy storage systems and simulation of the behavior in multi RES microgrid configuration

Transys modeling
for dimensioning
energy storage
systems in multi
sources RES
microgrid

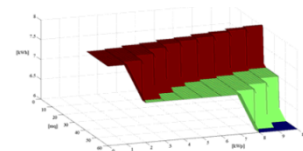


Fig.25 Taglia degli accumulatori Li-Ion necessari per ottenere LPSP=0.0003

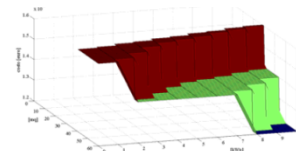


Fig.26 Costo del solo sistema di accumulo

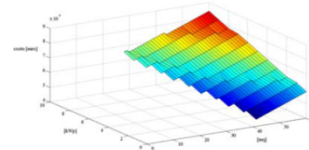
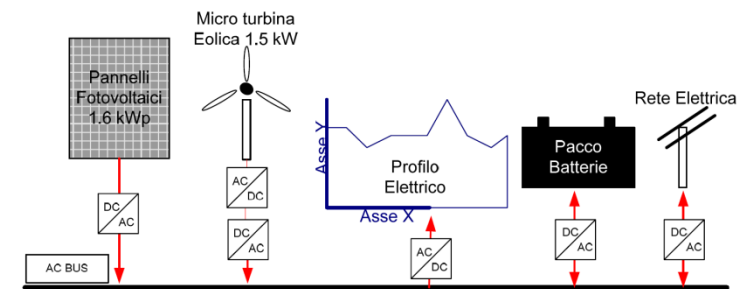
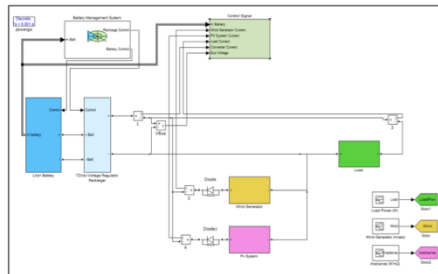


Fig.27 Costo complessivo del sistema di generazione ibrido



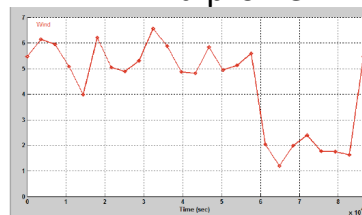
- ☐ Cost analysis
- ☐ Energy storage calculation and number of batteries definition

Simulink approach for dynamic behavior in different scenarios

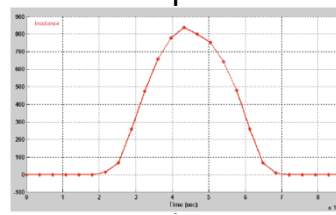


Simulink Hybrid system modeling

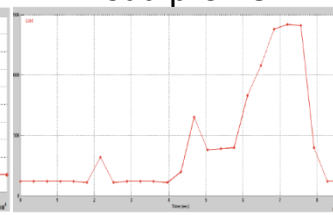
Wind profile



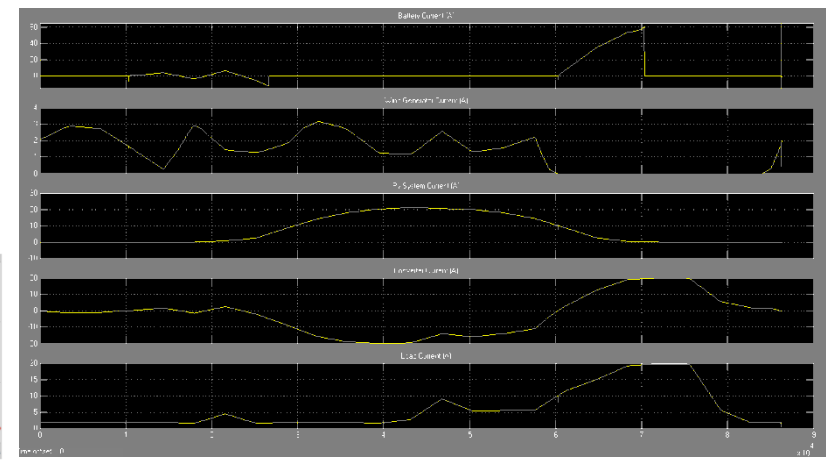
Solar profile



Load profile



Simulation of energy flows



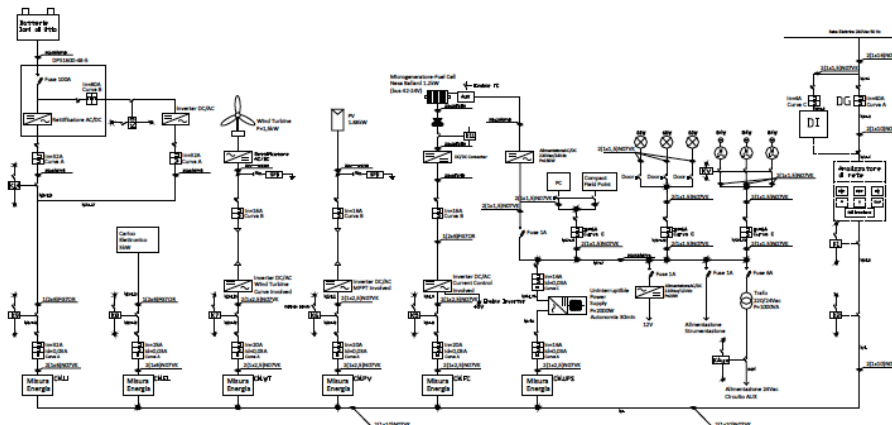
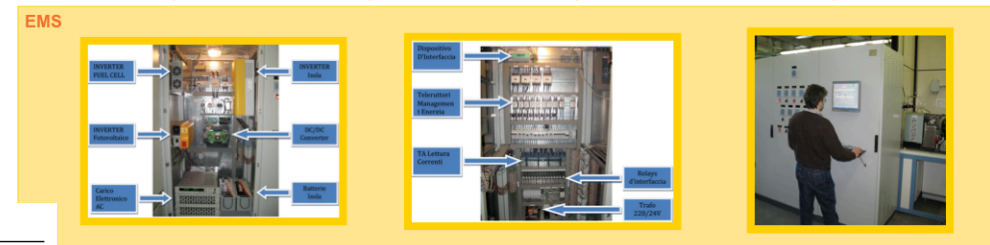
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Development of a microgrid test bench for building scale studies



PV Plant (1,8 kWp)
Vertical Axis Wind Turbine (1,5 kW)
Li-Ion Energy storage system (2,3 kWh)
PEM Fuel Cell System (1,2 kW)

Programmable Load
Stand alone-Grid tied configurations
Battery management
Power quality evaluation

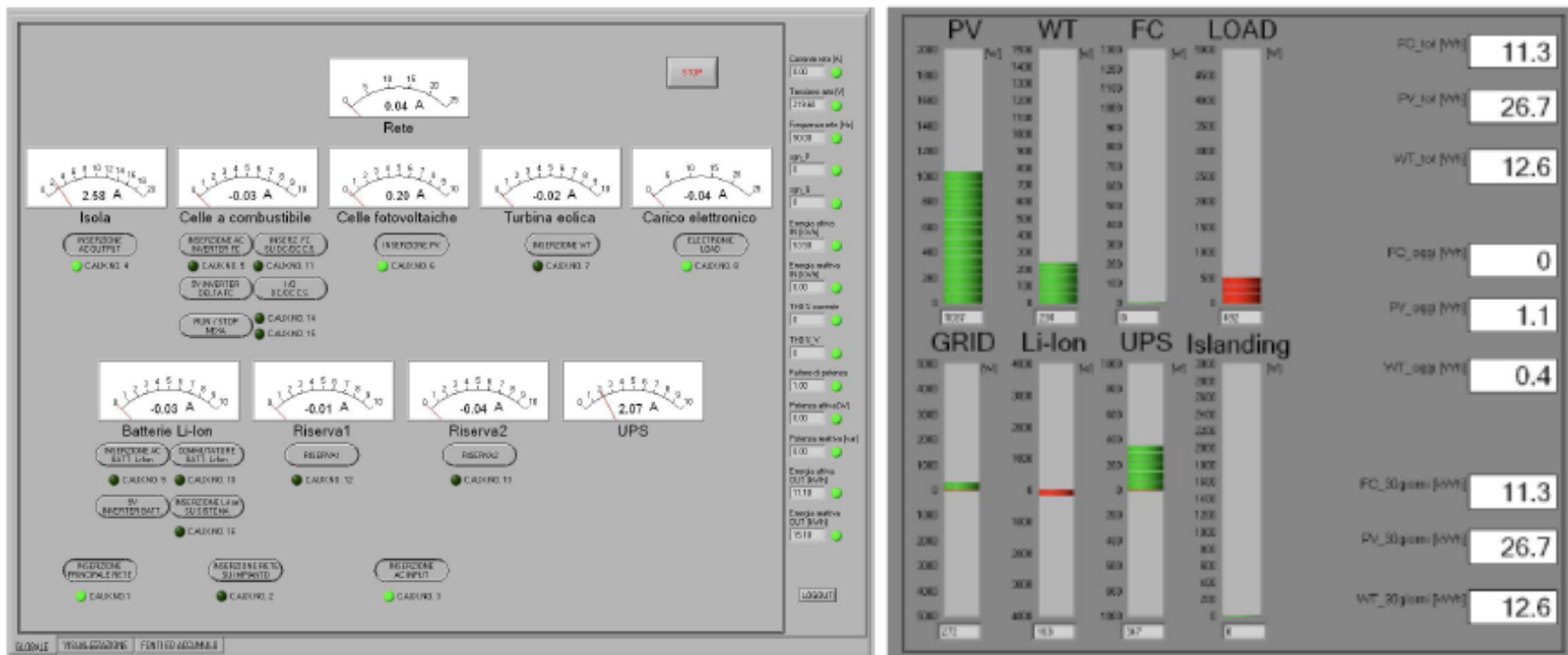


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Development of a microgrid test bench for building scale studies



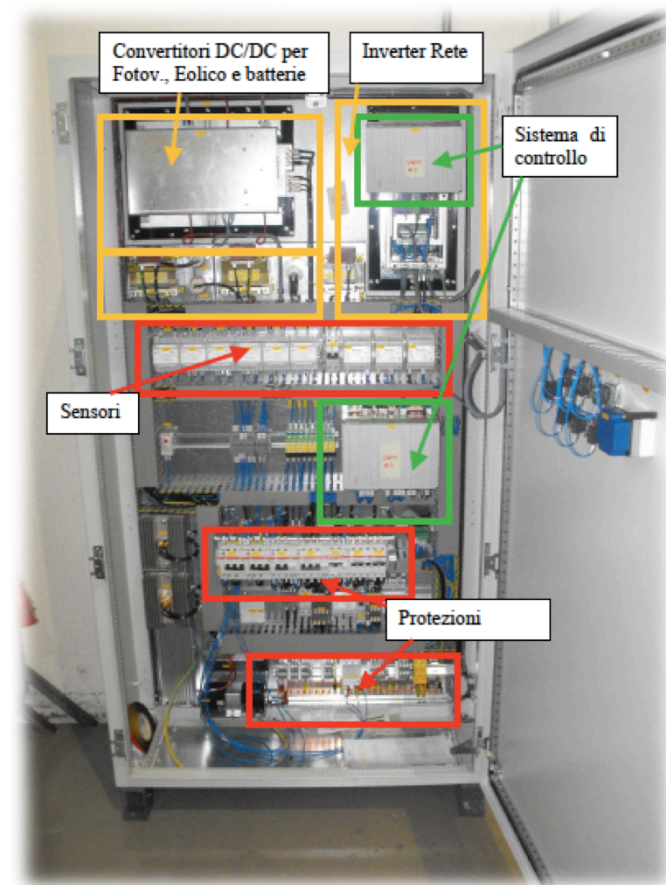
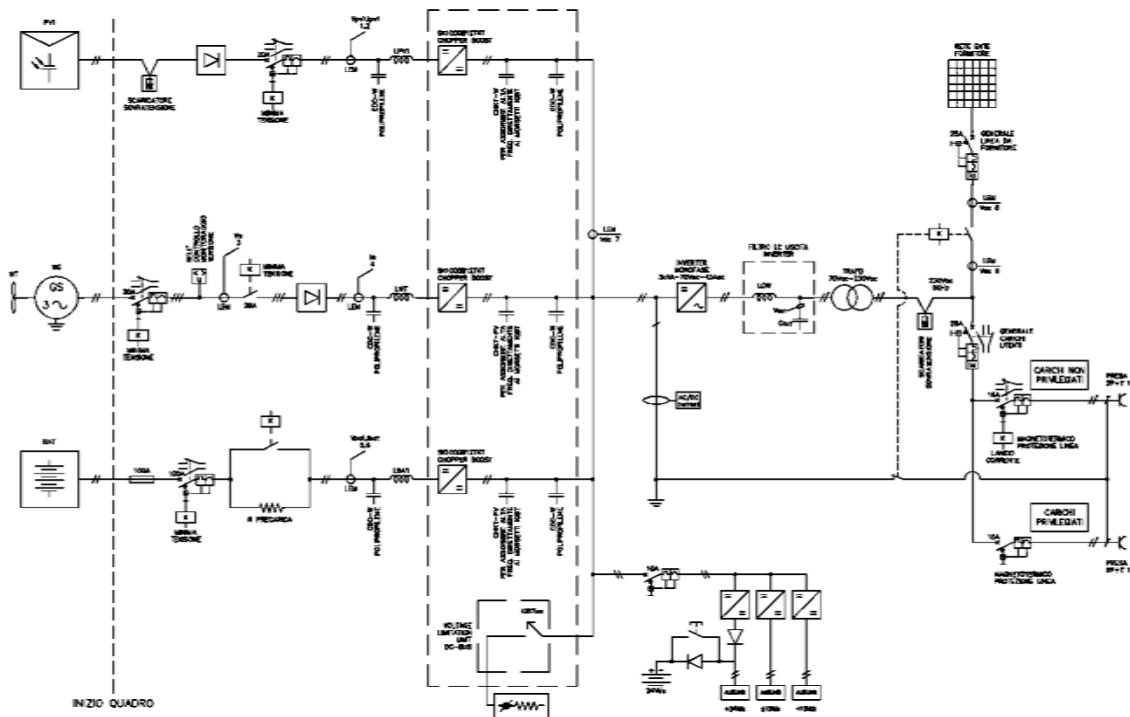
Design and optimization of a management software of the plant and of the energy storage system. HMI and control system developed by CNR-ITAE



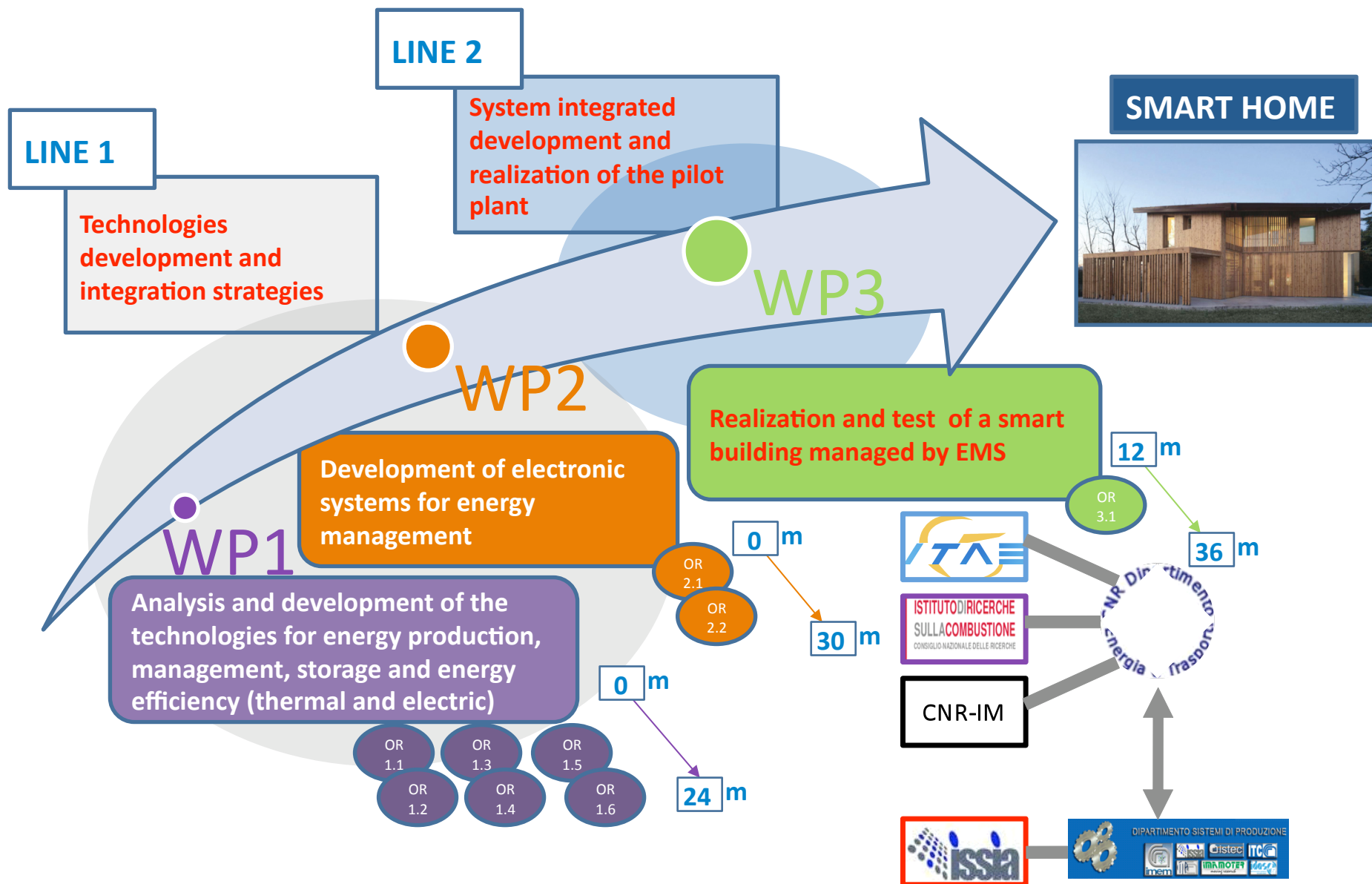
ITALIAN MINISTRY OF ECONOMIC DEVELOPMENT – CNR AGREEMENT

Development of a microgrid test bench for building scale studies

Politecnico of Milan and CNR multisource hybrid microgrid development



SMART HOME PROJECT



SMART HOME PROJECT

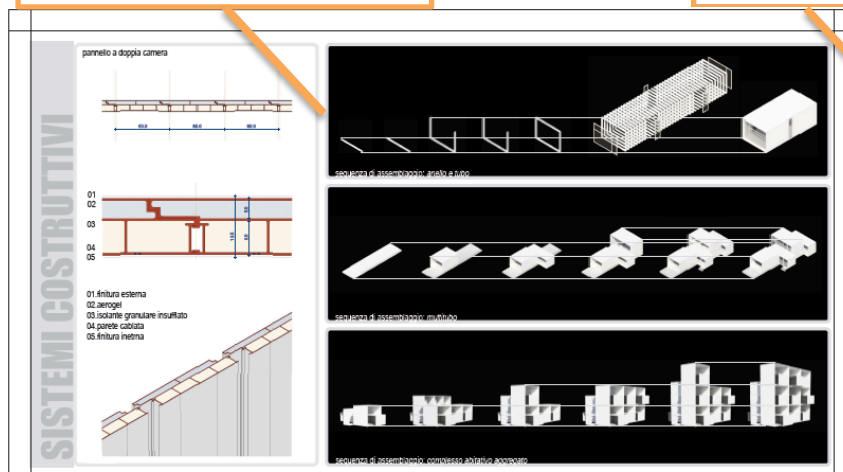
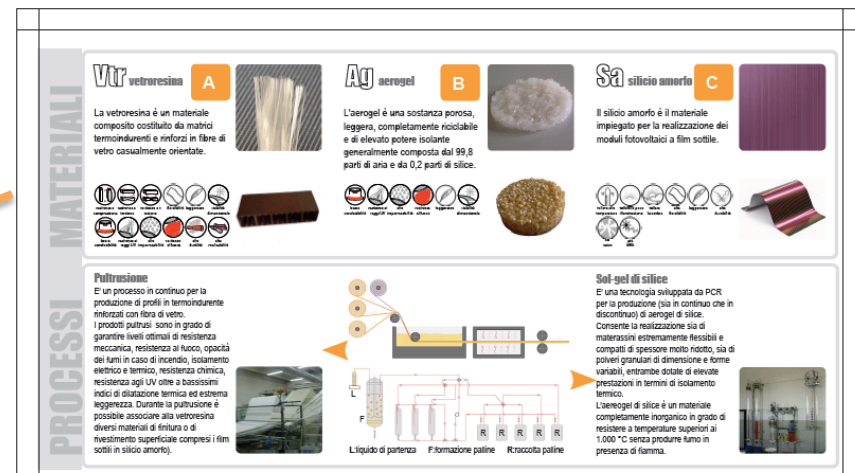
Concept development

Innovative energy technologies coming from the results of research

Innovative materials

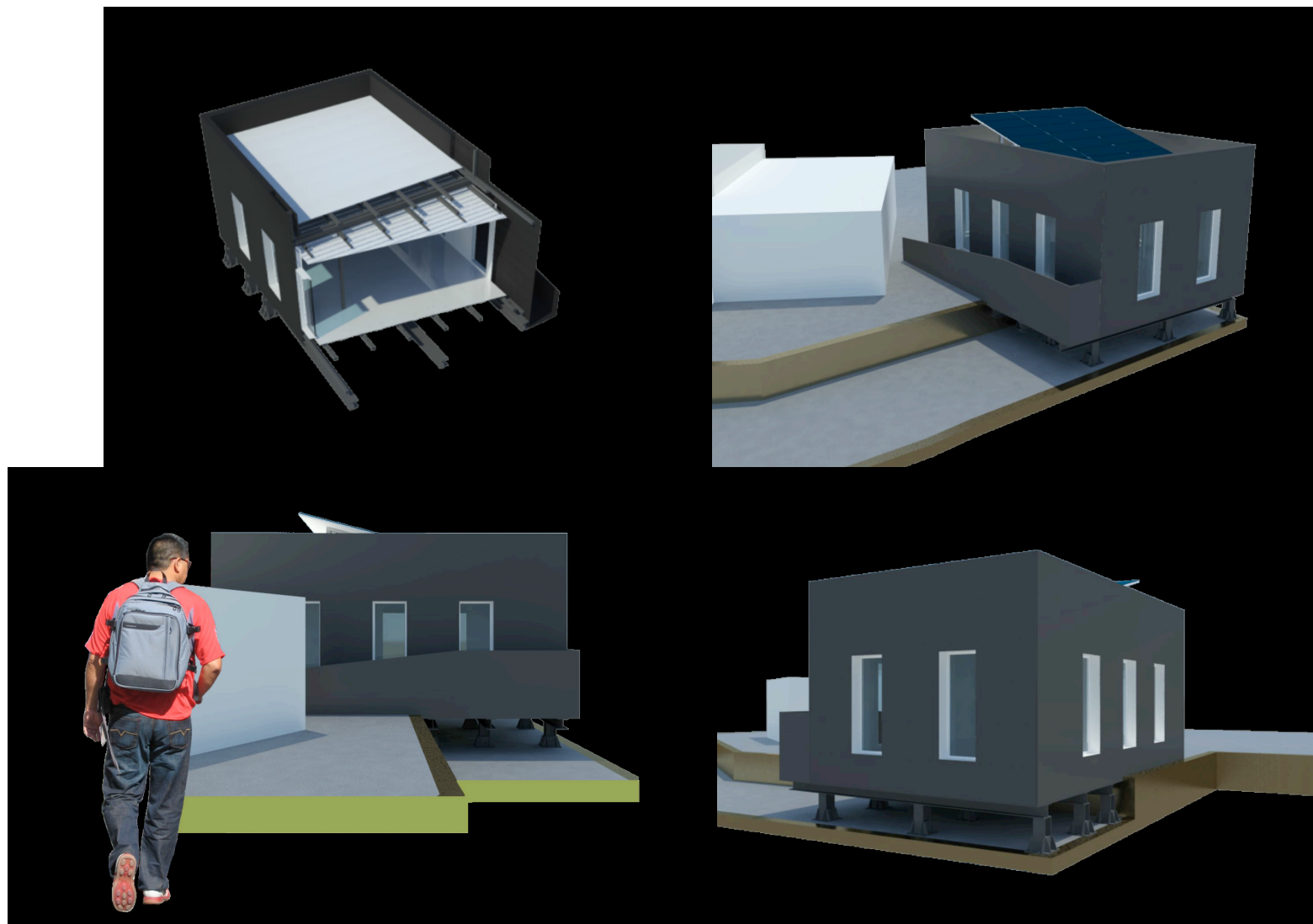
Modular designing

Concept



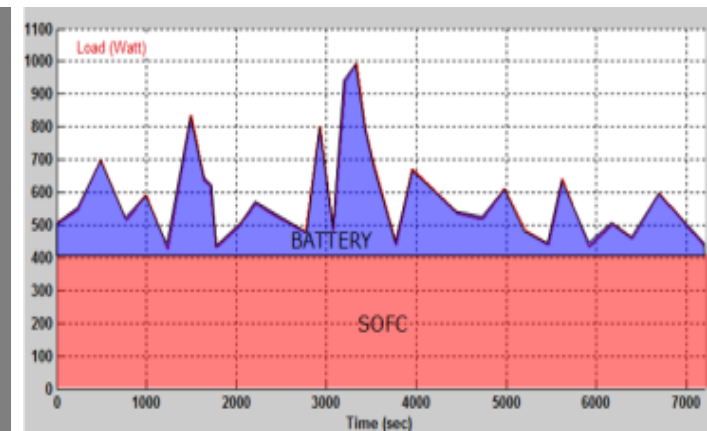
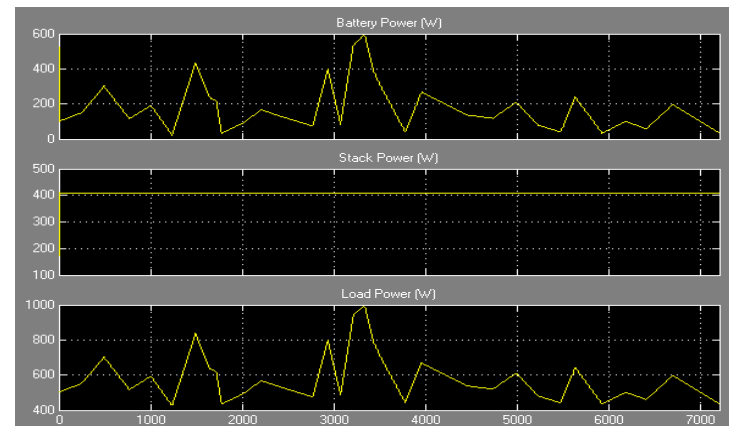
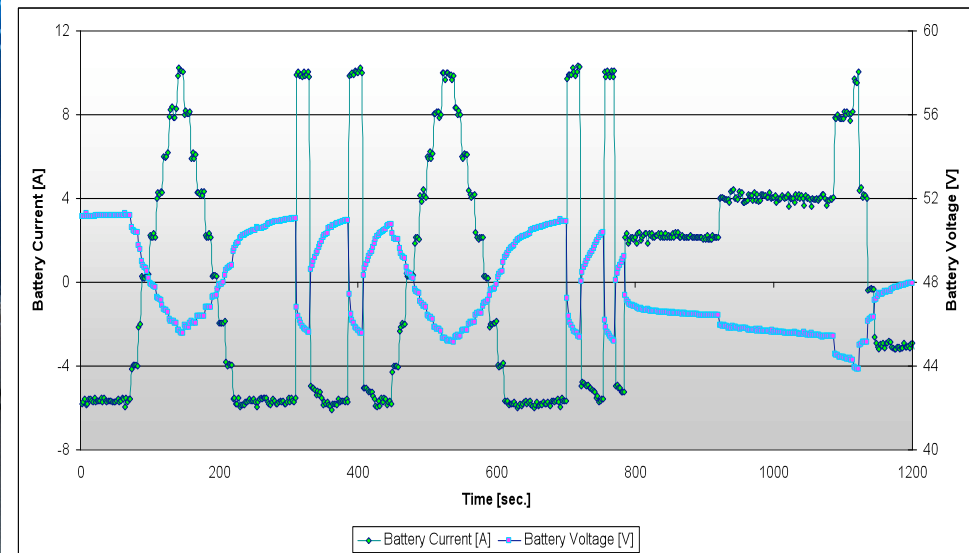
SMART HOME PROJECT

PROJECT



SMART HOME PROJECT

Development of a hybrid (fuel cell and battery) SOFC stack of 500 W by natural gas.
Characterization of the prototype using Simulink modeling.

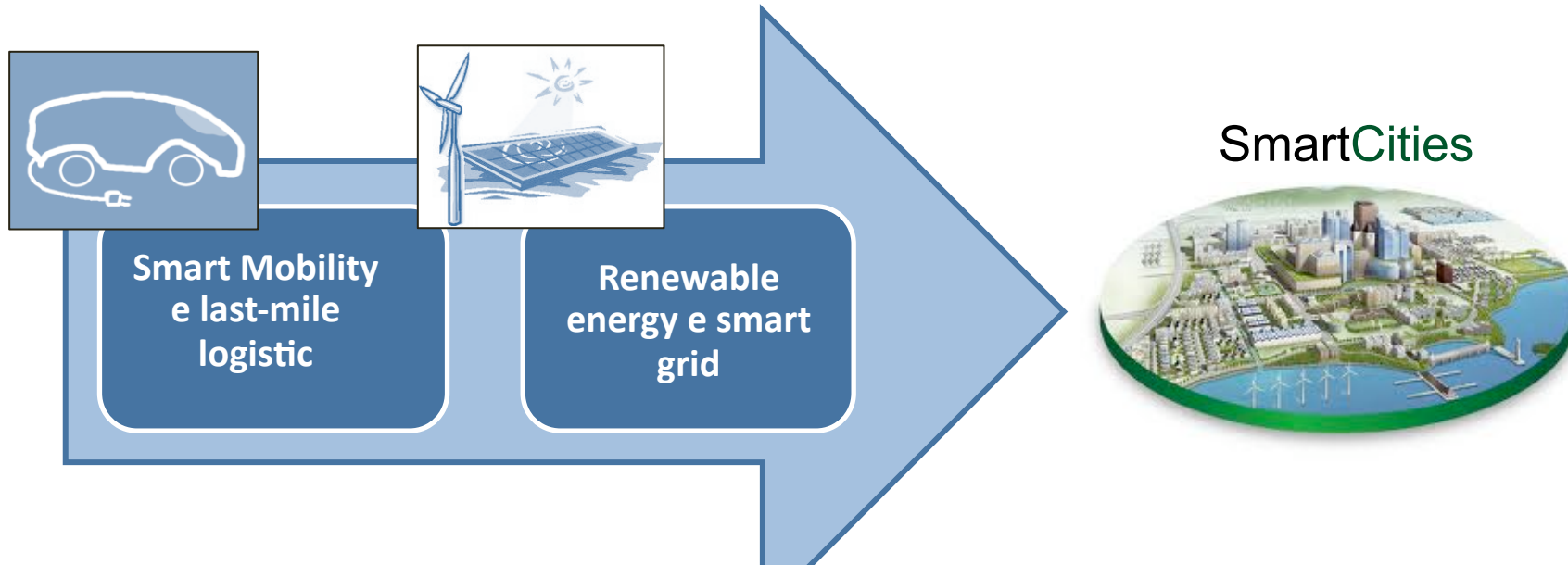


SMART CITIES PROJECT – i-NEXT



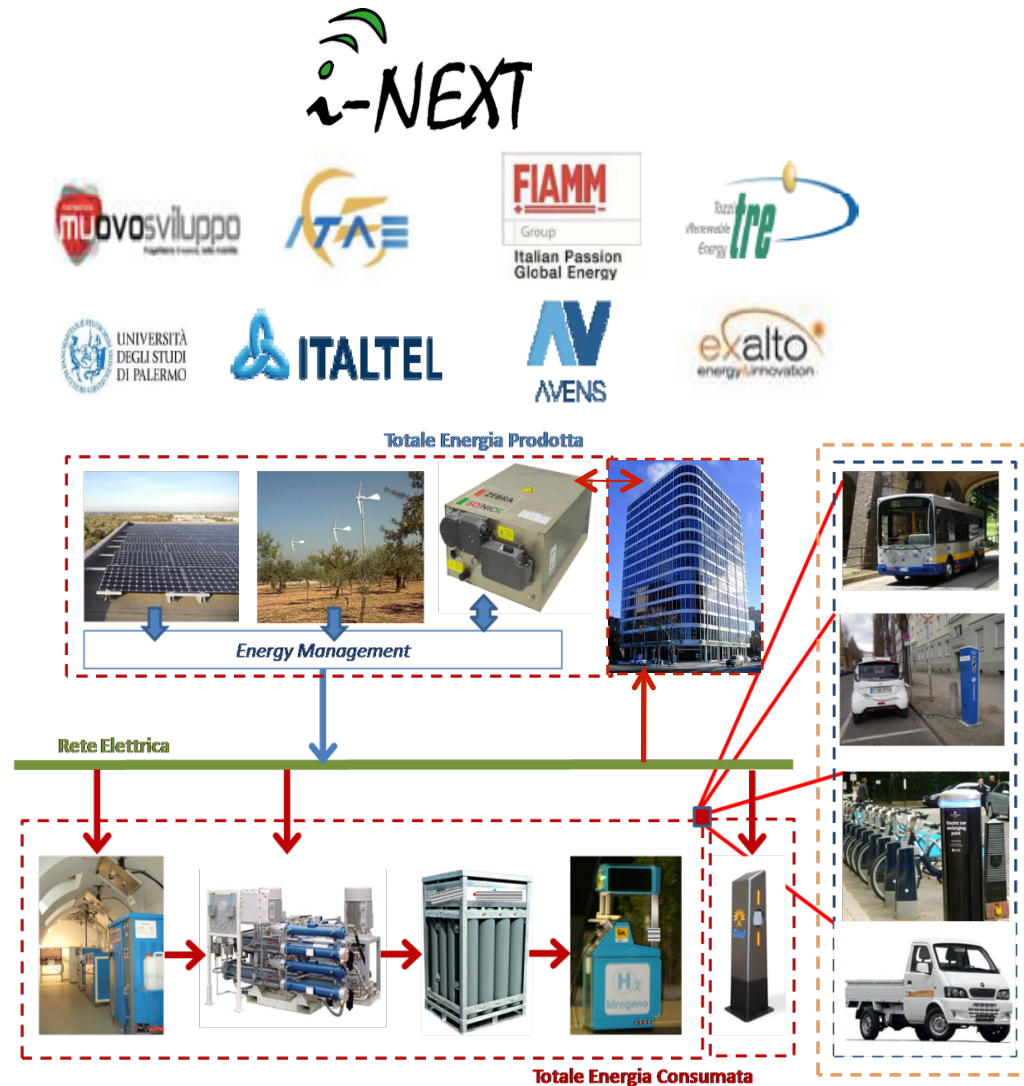
investiamo nel vostro futuro

Innovation for Green **NE**nergy and **X**change in **T**ransportation



The project, within the framework "Smart mobility and last-mile logistic" and "Renewable energy and smart grid", aims to support the innovation both in transport and energy demand of buildings fields.

SMART CITIES PROJECT – i-NEXT



Experimental phase will be addressed to the development of renewable energy plants by using advanced electrochemical storage and production/storage hydrogen systems able to interface with electric vehicles, smart Grid and ICT platform.

SMART CITIES PROJECT – i-NEXT

Cities involved



BAGHERIA (PA)



PARCO VALLE DEI TEMPLI (AG)



CITTADELLA UNIVERSITARIA DI PALERMO (PA)

OFF-GRID energy station – OASIS ONE



ENERGY INDEPENDENCE

USABILITY OF RENEWABLE ENERGY

CLEAN ALTERNATIVE TO FOSSIL FUELS

HIGH DENSITY STORAGE SYSTEM

LOW ENVIRONMENTAL IMPACT

CONTAINER SYSTEM PLUG & PLAY

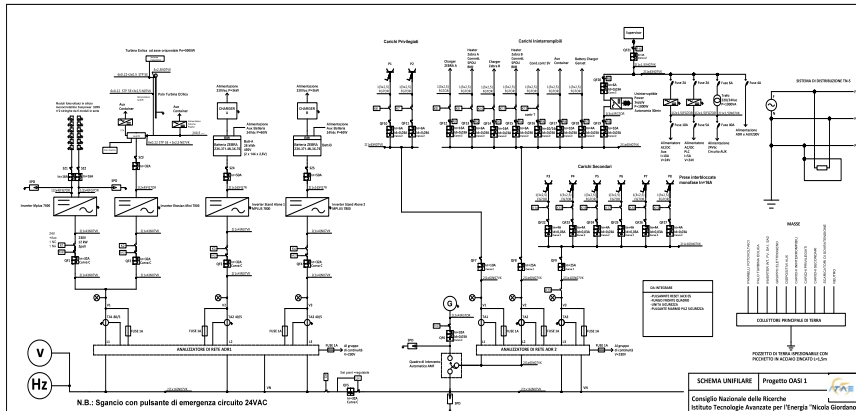
TOTALLY OFF GRID SYSTEM



OFF-GRID energy station – OASIS ONE



Design and Concept Development



Installation and Technical Support



Vicenza
Opening

Munich
INTERSOLAR



SYMPOSIUM ON MICROGRID
Santiago 11-12 September 2013

CNR-ITAE Microgrid Research
Speaker: Vincenzo Antonucci



SANTIAGO 2013
**SYMPOSIUM ON
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CNR-ITAE Microgrid Research

Institute for Advanced Energy Technologies "Nicola Giordano", Messina, Italy